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PATENT APPLICATION

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IN THE
UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Nauka et al.
Confirmation No.: 1558

Application No.: 10/698,717
Examiner: Van T. Pham

Filing Date: October 31, 2003
Group Art Unit: 2656

Title: DATA STORAGE DEVICE INCLUDING CONDUCTIVE PROBE AND FERROELECTRIC STORAGE MEDIUM

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TRANSMITTAL OF APPEAL BRIEF

Transmitted herewith is the Appeal Brief in this application with respect to the Notice of Appeal filed on Feb. 23, 2007 .

The fee for filing this Appeal Brief is (37 CFR 1.17(c)) $500.00.

(complete (a) or (b) as applicable)

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136(a) apply.

☐ (a) Applicant petitions for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d)) for the total number of months checked below:

☐ 1st Month $120 ☐ 2nd Month $450 ☐ 3rd Month $1020 ☐ 4th Month $1590

☒ The extension fee has already been filed in this application.

☐ (b) Applicant believes that no extension of time is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

Please charge to Deposit Account 08-2025 the sum of $ 500 . At any time during the pendency of this application, please charge any fees required or credit any over payment to Deposit Account 08-2025 pursuant to 37 CFR 1.25. Additionally please charge any fees to Deposit Account 08-2025 under 37 CFR 1.16 through 1.21 inclusive, and any other sections in Title 37 of the Code of Federal Regulations that may regulate fees.

Respectfully submitted,

Nauka et al.

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Patent
Docket No. 200310817-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

APPEAL NO. ________________

In re Application of:
Nauka et al.

Serial No. 10/698,717
Filed: October 31, 2003

Confirmation No.1558
Group Art Unit: 2656
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For: DATA STORAGE DEVICE INCLUDING CONDUCTIVE PROBE AND FERROELECTRIC STORAGE MEDIUM

APPEAL BRIEF

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1. REAL PARTY IN INTEREST

The real party in interest is the assignee, Hewlett-Packard Development Company.

2. RELATED APPEALS AND INTERFERENCES

No appeals or interferences are known to have a bearing on the Board's decision in the pending appeal.

3. STATUS OF CLAIMS

Claims 1-37 are pending in this application.

Claims 1-6, 8, 10, 12-27, and 29-37 are cancelled.

Claims 7, 9, 11, and 28 are rejected.

The rejections of claims 7, 9, 11, and 28 are being appealed.

4. <u>STATUS OF AMENDMENTS</u>

A first after-appeal amendment was filed on August 11, 2006 to reduce the number of issues for appeal by cancelling claims 1-6, 8, 13, 21-24, 30, 27 and 36-37 and rewriting dependent claims 7, 9-12, 25-26 and 28-29 in independent form. An advisory action dated August 18, 2006 indicated that the first after-appeal amendment was entered.

Another office action was issued on Nov. 24, 2006 in an attempt to re-open prosecution. Another after-appeal amendment was filed March 31, 2007, which was after the filing date of a second Notice of Appeal (Feb. 23, 2007), but before the filing of this second Appeal Brief. That second after-appeal amendment further reduced the number of issues for appeal by cancelling claims 10 and 25-26. An advisory action dated April 17, 2007 indicates that the after-appeal amendment was entered.

Yet another after-appeal amendment was filed on May 18, 2007, which is also before the filing of this second Appeal Brief. That third after-appeal amendment should further reduce the number of issues for appeal by cancelling claims 12 and 29. Although entry has not been indicated, the third after-appeal amendment is expected to be entered.

5. SUMMARY OF CLAIMED SUBJECT MATTER

Claims 7, 9 and 11 all recite a data storage device comprising a conductive probe having a tip, a substrate including a semiconductor portion, and a data storage medium. The data storage medium includes a layer of poled ferroelectric material for storing data. The ferroelectric layer is on the substrate, between the tip and the substrate. The semiconductor portion and the ferroelectric layer form an electrical junction.

An exemplary data storage device 110 is illustrated in Figure 1 and described in paragraph 15 of the specification. The device 110 includes an array of conductive probes 112, a substrate 114, and a ferroelectric storage medium 116. The ferroelectric storage medium 116 includes a layer 118 of poled ferroelectric material. The poled ferroelectric layer 118 is on the substrate 114, between the substrate 114 and tips of the probes 112. The ferroelectric layer 118 functions as a ferroelectric storage medium or data recording layer.

According to paragraph 16, the ferroelectric layer 118 is poled to order its electrical dipoles in a uniform direction, and to define one of the binary states for the storage of information. Figures 2a and 2b illustrate the dipoles 210 in the ferroelectric layer 118 before poling and after poling.

Claims 7, 9 and 11 recite separate features of the data storage device. Claim 7 recites a protective layer covering the ferroelectric layer. The protective layer protects the ferroelectric layer, but does not interfere with interactions between the probe tip and the ferroelectric layer. An exemplary protective layer is referenced by numeral 122 in Figure 1 and described in paragraph 19. According to paragraph 25, the protective layer 122 also functions as a sacrificial layer, allowing the probes 112 to be dragged across it instead of the ferroelectric layer

118. Thus, the probes 112 damage the protective layer 122 instead of the ferroelectric layer 118.

Claim 9 recites a circuit for causing the conductive probe to perform block and bulk erasure operations. Paragraph 30 describes an example of a block erasure. A block erasure can be performed by dragging the probe tip along the ferroelectric layer 118 across multiple bits 413, while the circuit 120 (in Figure 1) applies a constant voltage bias to the probe 112 to restore the initial polarization of the bits. Bulk erasure may be performed by dragging the probe tips, or by heating the ferroelectric layer 118 above its Curie temperature and cooling off the ferroelectric material to room temperature in the presence of a poling field.

Claim 11 recites a read circuit for using a probe to sense changes in capacitance or leakage current of the junction formed by the ferroelectric layer and semiconductor substrate. An exemplary read circuit is referenced by numeral 120 in Figure 1.

An exemplary method of using the read circuit is described in paragraph 33 and illustrated in Figure 6a. As a probe 112 is scanned along the ferroelectric layer 118 (block 610), the circuit 120 uses the probe 112 to sense local changes in junction capacitance or junction leakage current induced by the dipole polarization (block 612). These changes indicate whether polarity reversals occur at the bits.

Another example of detecting leakage current is illustrated in Figure 6e and described in paragraph 38. A probe 112 is scanned along the ferroelectric layer 118 (block 650) while a bias is applied between the probe 112 and the substrate 114. The circuit 120 senses a leakage current flowing through the ferroelectric layer 118 (block 652). Magnitude of the leakage current is modulated by the polarity of the bit being scanned 413, and thus can indicate polarity reversals.

Claim 28 recites a method of reading information from a ferroelectric layer. The method includes using a probe to sense changes in capacitance or leakage current of the junction. An example of this method is illustrated in Figure 6a and described in paragraph 33. Another example of this method is illustrated in Figure 6e and described in paragraph 38.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

a. Claims 11 and 28 are rejected under 35 U.S.C. §103(a) as being unpatentable over Cho U.S. Patent Publication No. 2003/0053400 in view of Kasanuki U.S. Patent No. 5,481,527.

b. Claim 9 is rejected under 35 U.S.C. §102(b) as being anticipated by Kasanuki.

c. Claim 7 is rejected under 35 U.S.C. §103(a) as being unpatentable over Kasanuki in view of Imaneka U.S. Patent No. 6,945,633.

7. <u>ARGUMENTS</u>

Kasanuki discloses a data storage device including a recording medium having a ferroelectric layer 3 (col. 7, lines 23-25 and 29-36) and an electrode layer 4. The electrode layer 4 may be made of a semiconductor material (col. 7, lines 25-28). Kasanuki's device further includes a conductive probe 1 having a tip (col. 7, lines 37-38). As shown in Figure 1, the ferroelectric layer 3 is between the probe tip and the electrode layer 4.

To write (record) data to the ferroelectric layer 3, a pulse voltage is applied between the probe 1 and the electrode layer 4 (col. 7, line 62 to col. 8, line 4). As a result, there is a polarization of the ferroelectric layer 3. Direction of the polarization is determined by the polarity of the pulse voltage.

To read (reproduce) data stored on the recording medium, a voltage is applied between the probe 1 and the electrode layer 4, and the probe 1 is scanned across the ferroelectric layer 3 (col. 7, lines 5-9). An electrostatic force acting on the electrode (due to interaction with the stored charges in the ferroelectric layer) causes a displacement of the probe 1 (col. 8, lines 13-16). Data is reconstructed from the detected displacement (col. 8, lines 17-21).

Kasanuki describes other embodiments of the data storage device. Some embodiments use a tunnel current to record and reproduce data (col. 8, lines 33-37). In a third embodiment described at col. 12, lines 8+, a current-voltage converting circuit 93 detects a tunnel current flowing from the probe 1 to the recording medium, amplifies the tunnel current, and converts it into a voltage (col. 12, lines 33-36). Detected signals are extracted as reproduced signals though a high pass filter 92 and demodulation circuit 91 (col. 12, lines 36-38).

Cho discloses a device including a dielectric material, a probe having a tip in contact with one surface of the dielectric material, and an electrode in contact with an opposite surface of the dielectric material (paragraph 10). Cho refers to the probe and electrode as first and second electrodes.

A record signal generating device and signal applying device apply a record signal to the probe (paragraph 10). According to Cho, the application of the record signal changes the polarization state in a small area of the dielectric material, thus recording information in the area (paragraph 25).

This information can be read by the combination of an oscillation device, a demodulation device, and a signal reproduction device (paragraph 27). According to Cho's paragraph 28, a capacitance is formed between the probe and the electrode. The capacitance is varied with a state of the polarization of the dielectric. An oscillation circuit generates an oscillation signal having a frequency that varies with the capacitance.

I

REJECTION OF CLAIMS 11 AND 28 UNDER 35 U.S.C. §103 AS BEING UNPATENTABLE OVER CHO IN VIEW OF KASANUKI

Cho does not teach or suggest a data storage device including an electrical junction formed by a semiconductor portion and a ferroelectric layer. Figures 1-3 and 5 of Cho illustrate a dielectric record medium 11 including a dielectric thin film 12. Cho lists many different materials for the dielectric recoding medium 11 including ferroelectrics (paragraph 58).

The dielectric record medium 11 is on an electrode 13. Paragraph 72 discloses that the electrode 13 may be made of a material such as platinum. Paragraph 72 also discloses that the electrode 13 may be formed on a silicon substrate. Thus, the dielectric thin film 12 is on one side of the electrode 13, and the silicon substrate is on the other side of the electrode. Therefore, the silicon substrate and the thin dielectric film 12 do not form the electrical junction recited in claim 11[1].

Cho does not teach or suggest how to read data from the type of junction recited in claim 11.

Kasanuki describes a method of reading from the type of junction recited in claim 11. However, Kasanuki's read method is different than Cho's method and the method recited in claim 11. Kasanuki does not teach or suggest a read circuit for using a probe to sense changes in capacitance or leakage current of the junction. Instead, Kasanuki discloses a read method in which a voltage is applied between the probe 1 and the electrode layer 4, and the probe 1 is scanned across

[1] Page 5 of the latest office action characterizes the electrode 13 as a semiconductor substrate. However, Cho does not support the characterization.

the ferroelectric layer 3 (col. 7, lines 5-9). An electrostatic force acting on the electrode (due to interaction with the stored charges in the ferroelectric layer) causes a displacement of the probe 1 (col. 8, lines 13-16). Data is reconstructed from the detected displacement (col. 8, lines 17-21).

Thus, Kasanuki does not teach or suggest the differences between claim 11 and Cho.

Yet the examiner maintains that claim 11 is obvious. However, the examiner does not explain why claim 11 is obvious in view of Kasanuki. That is, he has not resolved the level of skill in the art, as required by the Graham test. Although a finding of teaching, suggestion or motivation in the prior art is no longer required,[2] the Supreme Court still requires a reason for alleging obviousness. The examiner offers none.

Prima facie obviousness of claim 11 has not been established. Therefore, the '103 rejection of claim 11 should be withdrawn.

For the same reasons, prima facie obviousness of claim 28 has not been established. Therefore, the '103 rejection of claim 28 should be withdrawn.

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[2] KSR Int'l v. Teleflex Inc., 550 U.S. ____ (2007).

II
REJECTION OF CLAIM 9 UNDER 35 U.S.C. §102 AS BEING ANTCIPATED BY KASANUKI

Kasanuki does not teach or suggest a circuit for causing his probe 1 to perform block and bulk erasure operations. Kasanuki's devices perform erasure the same way that information is recorded: one bit at a time. See col. 12, lines 52-56; and col. 18, lines 14-21.

Page 4 of the office action establishes that Kasanuki discloses all elements of claim 9, ***except*** a circuit for causing the conductive probe to perform block and bulk erasure operations.

Page 2 alleges that claim 9 reads on Kasanuki because paragraph 30 of the specification states that a block erasure can be performed "by dragging the probe tip along the ferroelectric layer across multiple bits at a time." However, Kasanuki doesn't teach or suggest block erasure by dragging a probe tip, nor does Kasanuki disclose erasing multiple bits at a time.

Moreover, claim 9 also recites bulk erasures in addition to block erasures. Paragraph 31 states that a bulk erasure can be performed over the entire ferroelectric layer 118 by dragging the probe tips, or by heating the ferroelectric layer 118 above its Curie temperature and cooling off the ferroelectric material to room temperature in the presence of a poling field. Kasanuki doesn't teach or suggest such bulk erasure.

Page 2 of the latest office action also cites a passage out of Kasanuki ("In an information processing apparatus ... , resonance is likely to occur in the scanning mechanism if the scanning frequency increases"). However, the relevance of the passage is not clear, and the office action does not explain how it relates to block and bulk erasure operations.

Thus, Kasanuki does not teach or suggest all of the claim features of claim 9. Therefore, claim 9 should be allowed over Kasanuki.

III
REJECTION OF CLAIM 7 UNDER 35 U.S.C. §103 AS BEING UNPATENTABLE OVER KASANUKI IN VIEW OF IMANEKA

Kasanuki and Imaneka, alone and in combination, do not teach or suggest a data storage device including a conductive probe having a tip, a substrate, a ferroelectric layer, and a protective layer covering the ferroelectric layer, the protective layer not interfering with interactions between the probe tip and the ferroelectric layer.

The office action appears to acknowledge that Kasanuki does not teach or suggest a protective layer covering the ferroelectric layer. However, page 5 of the latest office action cites Figure 8b of Imaneka, alleges that it shows a data storage device having a protective layer 33 covering a ferroelectric layer 32 [*sic*], and concludes that it would be obvious to cover Kasanuki's ferroelectric layer to reduce reduction environment (Kasanuki, col. 5, lines 40-55).

Imaneka does not support the allegations or the conclusion. Imaneka discloses a liquid discharge head for thermal ink jet printing (col. 1, lines 14-17 and 41-45). Figure 8b illustrates a circuit element formed on an element substrate of a liquid discharge head (col. 11, lines 5-7). A ferroelectric material film 32 is located between layers 30 and 31, thus constituting a capacitor (col. 16, lines 16-19). Barrier layers 33 are formed in the boundaries surfaces of the film 32 with the layers 30 and 31 (col. 16, lines 19-22).

The barrier films 33 purportedly address a problem that occurs when an SiN interlayer film is formed during manufacture of the discharge heads: a reduction atmosphere is created (col. 16, lines 29-35). The barriers 33 purportedly prevent hydrogen (in the reduction atmosphere) from degrading the ferroelectric material film 32 (col. 16, lines 35-39).

The reduction atmosphere might be a concern for the fabrication of discharge heads. However, the record does not indicate that the reduction atmosphere is a concern for Kasanuki's data storage device.[3] Therefore, the record does not provide a reason for adding Imaneka's protective barriers to the ferroelectric recording medium of Kasanuki's data storage device.

Moreover, Imaneka does not teach or suggest the type of protective layer recited in claim 7. Claim 7 recites a protective layer that does not interfere with interactions between the probe tip and the ferroelectric layer. Imaneka only suggests a material that prevents hydrogen from degrading the ferroelectric film 32.

More generally, Imaneka isn't relevant. Imaneka's barrier films 33 offer protection against chemical damage (resulting from chemical interactions between the ferroelectric and ambient that surrounds it), whereas the protective layer of claim 7 protects a ferroelectric layer against mechanical damage (as expected when the probe makes physical contact with the ferroelectric layer).

[3] Column 5, lines 40-55 of Kasanuki merely states that it is desirable to have a highly durable and reliable recording medium.

Imaneka is not even analogous art, and therefore cannot be used in the ‘103 rejection. “In order to rely on a reference as a basis for rejection of an applicant’s invention, the reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned. The field of Imaneka’s field of endeavor is thermal ink jet printing, whereas the applicants’ field of endeavor is data storage. Imaneka is concerned with the problem caused by a reduction hydrogen during fabrication of a liquid discharge head, whereas the applicants’ concern with respect to claim 7 is protecting the ferroelectric layer from mechanical damage during read and write operations.

For these reasons, the ‘103 rejection of claim 7 should be withdrawn.

For the reasons above, the rejections of claims 7, 9, 11, and 28 should be withdrawn. The Honorable Board of Patent Appeals and Interferences is respectfully requested to reverse these rejections.

Respectfully submitted,

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8. CLAIMS APPENDIX

Claims 1-6 (Cancelled)

7. (Previously presented) A data storage device comprising a conductive probe having a tip; a substrate including a semiconductor portion; a data storage medium including a layer of poled ferroelectric material for storing data, the ferroelectric layer on the substrate, between the tip and the substrate, the semiconductor portion and the ferroelectric layer forming an electrical junction; and a protective layer covering the ferroelectric layer, the protective layer not interfering with interactions between the probe tip and the ferroelectric layer.

Claim 8 (Cancelled)

9. (Previously presented) A data storage device comprising a conductive probe having a tip; a substrate including a semiconductor portion; a data storage medium including a layer of poled ferroelectric material for storing data, the ferroelectric layer on the substrate, between the tip and the substrate, the semiconductor portion and the ferroelectric layer forming an electrical junction; and a circuit for causing the conductive probe to perform block and bulk erasure operations.

10. (Cancelled)

11. (Previously presented) A data storage device comprising a conductive probe having a tip; a substrate including a semiconductor portion; a data storage medium including a layer of poled ferroelectric material for storing data, the ferroelectric layer on the substrate, between the tip and the substrate, the semiconductor portion and the ferroelectric layer forming an electrical junction; and a read circuit for using the probe to sense changes in capacitance or leakage current of the junction.

Claims 12-27 (Cancelled)

28. (Previously presented) A method of reading information from a ferroelectric layer that is on a semiconductor substrate, and forms an electrical junction with the semiconductor substrate, the method comprising:

scanning a surface of the ferroelectric layer with a probe having a sharp tip, the tip having a diameter of several nanometers; and

using the probe and the semiconductor substrate to detect polarity reversals at designated locations on the ferroelectric layer, each polarity reversal at a designated location indicating a first stored value at that designated location, each non-reversal of polarity at an expected location indicating a second logic value stored at that designated location;

wherein the probe is used to sense changes in capacitance or leakage current of the junction.

Claims 29-37 (Cancelled)

9. <u>EVIDENCE APPENDIX</u>

None

10. <u>RELATED PROCEEDINGS APPENDIX</u>

None